DOCUMENT RESUME

ED 079 953 EM 011 263

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TITLE Changes in First-Grade Achievement and the Predictive Validity of I. Q. Scores, As a Function of an Adaptive Instructional Environment.
INSTITUTION Pittsburgh Univ., Pa. Learning Research and Development Center.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO LRDC-1973/5
PUB DATE 73
NOTE 17p.; Preprint of an article for Educational Technology

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Academic Achievement; Early Childhood Education; Educational Research; *Grade 1; Individual Differences; Individualized Instruction; *Instructional Innovation; *Intelligence Quotient; Intelligence Tests; Kindergarten; Learning Processes; Mathematics; *Predictive Validity; Reading
IDENTIFIERS Otis Lennon Mental Abilities Test; Stanford Achievement Test

ABSTRACT

A research project introduced changes into the kindergarten and 1st grade instructional programs of a developmental school. The purposes were to implement an adaptive instructional system which would teach children the basic psychological processes relevant to 1st grade reading and math achievement and which would accommodate individual differences among learners. Over a five year period researchers collected I.Q. data from the Otis-Lennon Mental Abilities Test and achievement data from the Stanford Achievement Test. The data indicated that, over time, the reading and math achievement scores of 1st graders rose significantly, while I.Q.s remained constant. Also, fewer children achieved below grade level and the percentage of variance in achievement scores explained by I. Q. scores dropped greatly. Thus, it was concluded that the adaptive instructional program increased achievement and lowered the predictive validity of I. Q. scores. It remained to be determined exactly which specific aspects of the innovative program contributed most to the maximization of the educational outcome. (Author/PB)

Changes in First-Grade Achievement and the Predictive Validity of I.Q. Scores, As a Function of an Adaptive Instructional Environment

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To appear in Educational Technology.

1973

The research reported herein was supported by the Learning Research and Development Center, supported in part by funds from the National Institute of Education (NIE), United States Department of Health, Education, and Welfare. The opinions expressed in this publication do not necessarily reflect the position or policy of NIE and no official endorsement should be inferred.

Abstract

Changes and innovations have been introduced into the primary-grade instructional program of a developmental school periodically over the past five years. The pervasive purpose of these modifications has been to define the elements of an adaptive instructional system wherein the individual differences of the learners are a critical variable. The instructional innovations are described, and data are presented to show significant gains in first-grade achievement that cannot be explained by I.Q. scores but, rather, appear to be directly related to the extent to which an adaptive mode of instruction has been achieved.

Changes in First-Grade Achievement and the Predictive Validity of I.Q. Scores, As a Function of an Adaptive Instructional Environment

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In his Presidential Address to the American Educational Research Association, Glaser (1972) suggests "new directions for educational research and practice (p. 5)." Acknowledging that the need has been recognized for many years (Thorndike, 1911; Washburne, 1925), he calls for the implementation in schools of an "adaptive mode" of education that provides both for: (1) teaching children, where indicated, the basic psychological processes that are directly related to classroom achievement (e.g., auditory and visual perceptual skills), and (2) alternative methods of instruction that are individually determined for each child. An intensive effort towards defining and developing an adaptive mode of education has been underway for some time at the Learning Research and Development Center (LRDC) and its developmental schools in the Pittsburgh, Pennsylvania area. The purpose of this paper is to report on some of the progress that has been achieved over the past few years. The task is far from accomplished, but it appears that our approximations are getting closer to the mark.

Method

The data to be presented here were derived over the past five years from the first-grade classes of a public school situated in suburban Pittsburgh. Many innovations in instructional programs have been introduced into all grades of that school over these years. At the kindergarten and first-grade levels, these include an organized method for teaching young children the basic psychological processes that relate directly to primary-grade reading and arithmetic achievement, as well as instructional programs that are designed to accommodate individual differences among the learners. All of these are cited below. This paper will not attempt to sort out differential effects. Rather, it will merely present longitudinal data that can be used to evaluate the overall effect of the innovations.

Measurement Instruments

The data to be presented are derived from two instruments: The Otis-Lennon Mental Abilities Test (1967) and the Stanford Achievement Test (1964).

Otis-Lennon Mental Abilities Test - This is a group-administered, norm-referenced test, customarily given by the school district at the end of kindergarten. In those cases where the child entered grade one without having attended kindergarten, the test is administered at the beginning of first grade. Scores are entered into the child's permanent record. It is from this source that the I.Q. data used in this study were obtained.

Stanford Achievement Test - This is a group-administered, norm-referenced test that is given annually to all students in the school district

during May of the academic year. It is scored by the teaching staffs of the respective schools and results are entered into the child's permanent record. It is from this source that the achievement data presented in this study were obtained.

Results

Five years of first-grade data were analyzed. Table 1 shows the number of students in each of those five groups and their mean I.Q. scores as derived from the Otis-Lennon Mental Abilities Test.

Table 1

Mean I.Q. Scores for First-Grade Children from 1968 to 1972

	N	I.Q. Scores	S.D.
1968	37	118.6	18.1
1969	42	108.3	17.9
1970	53	114.1	14.3
1971	44	113.0	13.5
1972	35	113.5	13.0

Analysis of variance of these I.Q. scores indicated no significant differences between means over the five years (ANOVA: $F = 2.24$, $df = 4, 206$, $p > .05$).

Stanford Achievement Test outcomes were also analyzed. To do this, first-grade mean stanine scores, for the years from 1968 to 1972, were calculated for the Language Arts subtests (Word Meaning, Paragraph Reading, Spelling, and Word Study Skills) and the Arithmetic subtest. Table 2 shows the average Language Arts and Arithmetic subtest stanine scores and the standard deviations for each of the five years.

Table 2

Mean Stanford Achievement Subtest Stanine Scores for First-Grade Classes from 1968 to 1972

	Language Arts		Arithmetic	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
1968	5.40	3.02	5.65	2.18
1969	4.86	2.91	5.55	2.10
1970	6.88	2.60	7.58	1.20
1971	6.93	2.65	7.11	1.76
1972	7.71	2.28	7.74	1.04

The change, across years, is evident. Analysis of variance shows these changes to be highly significant (Language Arts ANOVA: $F = 16.102$, $df = 4,206$, $p < .001$; Arithmetic ANOVA: $F = 15.668$, $df = 4,206$, $p < .001$).

To investigate further the changes that had occurred in achievement scores, Pearson Product Moment Correlations were calculated between the I.Q. scores of the five groups and their Language Arts and Arithmetic subtest scores. Table 3 shows these correlation coefficients.

Table 3

Pearson Product Moment Correlations Between I.Q. Scores and Stanford Achievement Subtest Stanine Scores

	Language Arts	Arithmetic
1968	.55	.64
1969	.53	.68
1970	.53	.70
1971	.57	.58
1972	.32	.51

It is noteworthy that the percentage of the variance in achievement test scores explained by I.Q. scores dropped from 30 percent to 10 percent in the Language Arts subtests and from 49 percent to 26 percent in the Arithmetic subtest. However, no consistent trends may, as yet, be claimed. The lower 1972 correlation coefficients may simply be a result of an unusual year.

To examine these data another way, regression slopes were calculated and plotted for the Arithmetic and Language Arts subtests, controlling on I.Q. scores. These are shown in Figures 1 and 2.

The changes in achievement scores, across years, are immediately evident in both figures (ANCOVA: Language Arts: $F = 20.73$, $df = 4,205$, $p < .001$; Arithmetic: $F = 26.27$, $df = 4,205$, $p < .001$). No statistically significant differences were found in the tests for Homogeneity of Regression (Language Arts: $F = 0.670$; Arithmetic: $F = 1.188$). Thus, although the slopes are drawn as calculated, they could also be accurately shown as parallel.

As yet another probe, the data were analyzed to determine the percentage of children over those five years who had earned stanine scores of 4 or less. These data are shown in Table 4. Once again, marked changes in the children's school achievement are obvious. In 1968, over 40 percent of the first-grade students scored below grade level in the Language Arts subtests; in 1972, this figure had diminished to a negligible 2.3 percent. Similarly, in 1968, over 30 percent scored below grade level in the Arithmetic subtest; in 1972, no child scored below the fifth stanine.

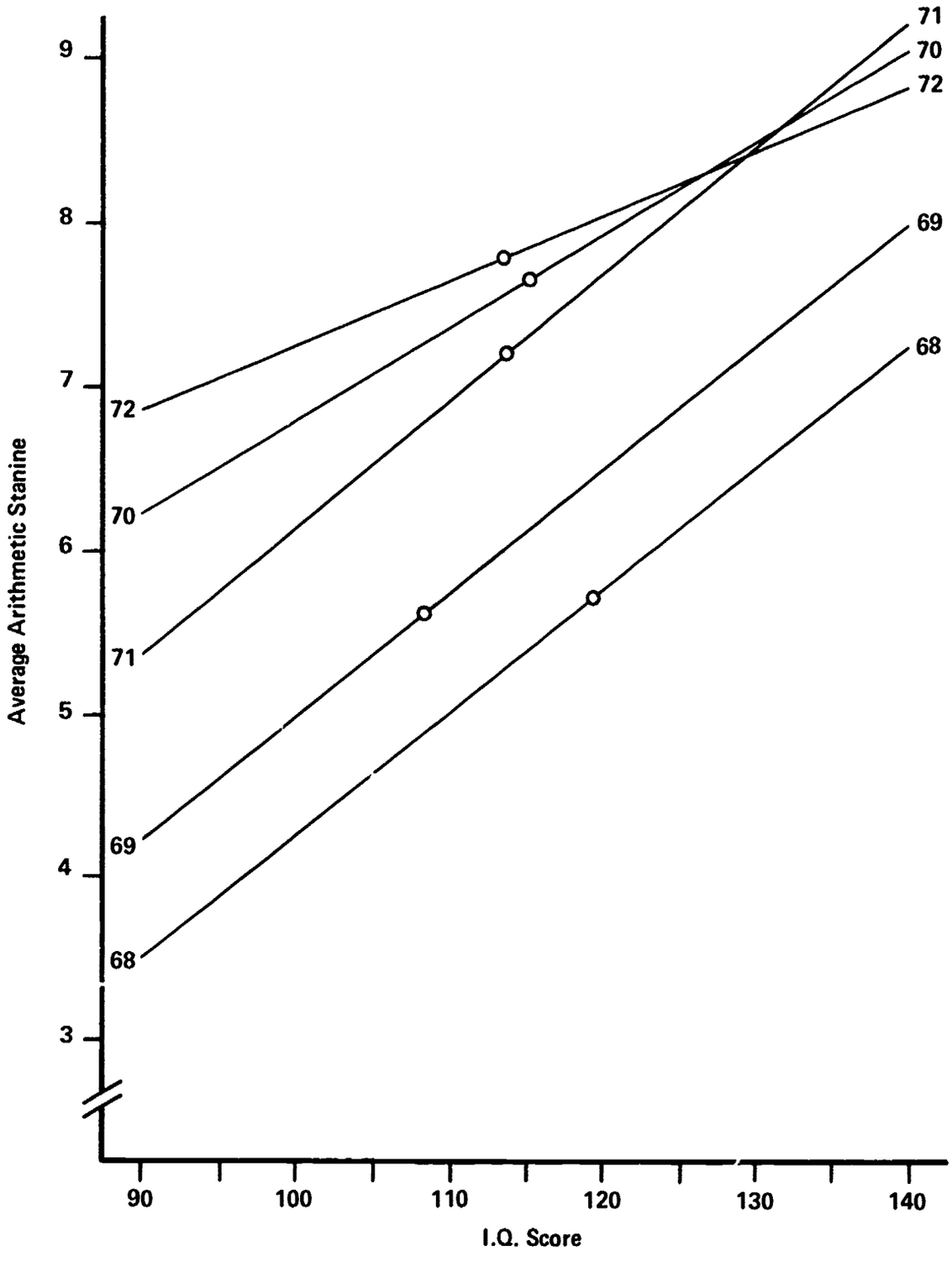

Figure 1. Regression Line of First-Grade Arithmetic Achievement Across I.Q. over Five Years.

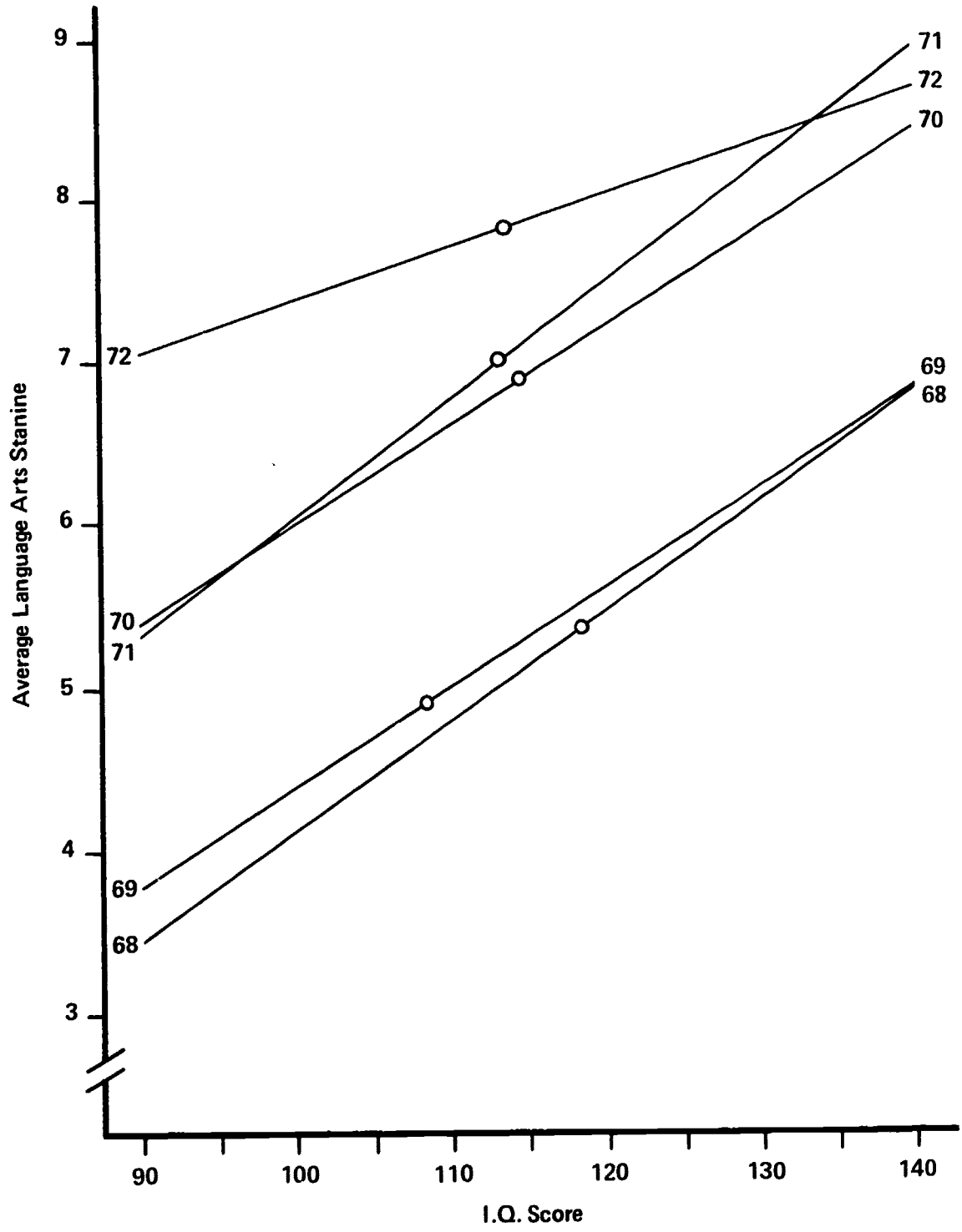

Figure 2. Regression Line of First-Grade Language Arts Achievement Across I.Q. over Five Years.

Table 4

Percentage of Stanford Achievement Subtest Stanine Scores of 4 or Lower

	Language Arts	Arithmetic
	%	%
1968	42.7	30.6
1969	43.9	28.6
1970	10.3	2.0
1971	10.1	13.6
1972	2.3	0.0

Discussion

It is highly apparent that favorable changes in first-grade achievement have evolved over the five years included in this study. I.Q. scores have become less important predictors of achievement test outcomes, at least in terms of absolute scores. Although the mean I.Q. scores of the five groups were not significantly different, achievement test scores rose steadily. Just as important, school failure, for all practical purposes, has been eliminated.

Thus, it appears that something approximating an adaptive mode of education has been achieved at the first-grade level of the school used in this study. To what can this be attributed? Referring to Glaser's remarks, cited at the beginning of this paper, two approaches were taken in this school: (1) programs were initiated in kindergarten to train basic psychological processes, and (2) reading, arithmetic, and science instructional programs that accommodate individual differences were introduced.

Figure 3 identifies these programs and the years in which they were introduced into the school.

Grade 1

1967 - 1968	1968 - 1969	1969 - 1970	1970 - 1971	1971 - 1972
Individually Prescribed Instruction (IPI) Mathematics IPI Reading	IPI Mathematics IPI Reading	PEP Visual Perceptual Skills Individualized Science ERP (limited use)	ERP PEP Individualized Science Visual Perceptual Skills Auditory Perceptual Skills	ERP IM Individualized Science Full Perceptual Skills Curriculum

Kindergarten

1967 - 1968	1968 - 1969	1969 - 1970	1970 - 1971	1971 - 1972
Standard Curriculum of This School District	Standard Curriculum of This School District	ERP (limited use started around January 1970)	ERP PEP Visual Perceptual Skills Auditory Perceptual Skills	NRS IM Full Perceptual Skills Curriculum

Figure 3. Basic Instructional Programs Used in Kindergarten and Grade 1 from Fall 1967 Through Spring 1972.

In 1968, the kindergarten program was not individualized; rather, it was similar to that used in all other kindergartens of this school district. The 1968 first-grade program was the one produced at LRDC in its beginning years. In 1969, the Primary Education Project (PEP) program (Beck 1967) was introduced into kindergarten and grade one, along with the visual-motor component of the Perceptual Skills Curriculum (Rosner, 1972), both then being developed at LRDC. In addition, the beginning levels of Individualized Science (Klopfer, 1971) were included in the first-grade program.

PEP represented an attempt to construct an organized method for insuring that each child learned basic quantification and classification skills. The visual-motor component of the Perceptual Skills Curriculum, following the same design as PEP in terms of employing criterion-referenced testing and teaching of a hierarchy of behavioral objectives, focuses on those skills that facilitate analysis and organization of spatial patterns. The lower levels of Individualized Science emphasize the development of the student's intellectual skills in relation to science in such areas as sorting, ordering, describing observations, and measurement.

These same programs, with some refinement, were continued in 1970, and a new early reading program (ERP: Beck, 1973) was tried out in the kindergarten. ERP supplemented the existing reading program by teaching strategies for letter-sound correspondences and blending sounds into words. In essence, it taught initial word attack skills.

All of these programs were continued in 1971, along with the first school trials of the auditory-motor component of the Perceptual Skills Curriculum. In 1972, the last year included in this study, the full Perceptual Skills Curriculum (Visual-Motor, Auditory-Motor, General-Motor, and Letters & Numerals) and a new Individualized Math program

(IM: Individualized Mathematics Project Staff, 1971) were used. IM absorbed PEP and extended its scope to encompass the first three grades of an elementary-school mathematics program. In addition, during that year, the first classroom trial of the New Primary Grades Reading System (NRS: Beck & Mitroff, 1972) was carried out in kindergarten; NRS absorbed and modified ERP.

All of these programs, described in detail elsewhere, are designed to be adaptive, recognizing both the individual differences among children and the practical aspects of classroom implementation.

The data provoke certain questions. Why is it that first-grade achievement improved markedly--ostensibly as an outcome of improved instructional programs, yet kindergarten achievement--as measured by the I.Q. test--did not change? On the one hand, I.Q. scores predicted the relative first-grade achievement of the children equally well across all five years (see Table 3); on the other hand, I.Q. scores predicted absolute achievement (test scores) less reliably over those same years (see Tables 1 and 2). One reasonable explanation could be that the I.Q. score derived from the instrument used in this study does not measure basic learning processes. Rather, it is merely another achievement test that enables one to sample what a child has already learned and from which a general intelligence factor can be extracted (Cooley, 1971).

If we can accept this notion--and certainly a careful analysis of the items of the I.Q. test is needed before conclusive statements can be made--then the question posed above can be answered simply. Namely, the innovative programs introduced into the kindergarten did not teach what the I.Q. test measured but did teach processes and information that were pertinent to first-grade learning. The inferences are clear: An adaptive educational environment may not alter the learner's general

intelligence but should, nonetheless, provide conditions that will maximize educational outcomes. In short, "organismic input" (Lohnes, 1972) may well be stable but a method for measuring "learning potential" has yet to be defined.

A second question--important, albeit perhaps less controversial: Which of the instructional innovations, described above, had relatively greater effects? It is impossible to tell from these data. The answer will be available as additional studies are completed. The important conclusion, insofar as this paper is concerned, is that effects were obtained--effects that offer evidence that an adaptive mode of education is indeed possible--at least in the first grade. The extent to which such effects will be maintained as the children progress through the higher grades is to be studied very carefully. The mission of LRDC--replacement of the traditional selective mode of instruction with one that is adaptive to individual differences--appears to be more attainable than it once did.

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